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University Examinations 2022/2023

FIRST YEAR, FIRST SEMESTER, SPECIAL/SUPPLEMENTARY EXAMINATION FOR THE
DEGREE OF BACHELOR OF SCIENCE IN CHEMISTRY

FIRST YEAR, FIRST SEMESTER, SPECIAL/SUPPLEMENTARY EXAMINATION FOR THE
DEGREE OF BACHELOR OF SCIENCE IN BIOLOGICAL SCIENCES

FIRST YEAR, FIRST SEMESTER, SPECIAL/SUPPLEMENTARY EXAMINATION FOR THE
DEGREE OF BACHELOR OF SCIENCE IN EDUCATION

SCH 3101: PHYSICAL CHEMISTRY I

DATE: AUGUST 2023

TIME: 2 HOURS

INSTRUCTIONS: *answer question one and any other two questions*

QUESTION ONE (30 MARKS)

- a) Distinguish;
- i) Homogenous from heterogeneous equilibria (2 marks)
 - ii) Reversible from irreversible reactions (2 marks)
- b) Calculate the pH of a 0.30M NaF solution given that the K_a value for HF is 7.2×10^{-4} (4 marks)
- c) Given that the kinetic energy, K of an ideal gas is given as $K = \frac{1}{2} m u^2$ show that the kinetic energy of the gas can be expressed as $E_k = \frac{3}{2} RT$ (4 marks)
- d) State two causes of deviation of gases from the ideal behavior (2 marks)
- e) Calculate solubility of CaF_2 ($K_{sp} = 4.0 \times 10^{-11}$) in a 0.025M NaF solution (4 marks)
- f) State the Hess's law of heat summations (2 marks)
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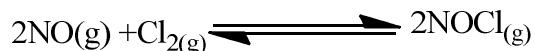
- g) Calculate the equilibrium constant for the reaction at 25°C
 $Zn/Zn^{2+} (0.1M)//Ag+(0.01M)/Ag$
 $E^0 = 0.93V$
 Given that $R=8.314J^{mol^{-1}}$, $F=96500C/mol$
- h) A sample of natural gas contains 0.824 moles of methane, 0.421 moles of ethane and 0.116 moles of propane. If the total pressure of the gases is 1.37 bar, what is the partial pressure of the gases? (6 marks)
- i) What is a buffer solution? (1 mark)

QUESTION TWO (20 MARKS)

- a) Discuss five postulates of the kinetic molecular theory (10 marks)
- b) Compare the pressure predicted for 0.8 litres of 4.4g of carbon dioxide at 0°C using the;
- Ideal gas equation (2 marks)
 - Van der waals equation (4 marks)
- (Given that $a = 6.581 atm mol^{-2}$, $b = 0.056 mol^{-1}$
 $C = 12.0, 0 = 16.0, R = 0.0821 l atm mol^{-1} k^{-1}$)
 Comment on your answer
- c) Given the general equation $aA + bB \rightleftharpoons cC + dD$
 Where a, b, c and d are stoichiometric coefficients and A and B are reactants, C and D are products. Write the equilibrium expression for this equation (1 marks)
- d) State three application of equilibrium constants (3 marks)

QUESTION THREE (20 MARKS)

- a) The reaction for the formation of nitrosyl chloride



Was studied at 25°C. the pressure at equilibrium were found to be:

$$P_{NOCl} = 1.2 atm$$

$$P_{NO} = 5.0 \times 10^{-2} atm$$

$$P_{Cl_2} = 3.0 \times 10^{-1} atm$$

Calculate the value of Kc for this reaction at 25°C $R = 8.314 J^{k^{-1}} mol^{-1}$ (5 marks)

- b) Calculate the standard enthalpy of formation of Naphthalene ($C_{10}H_8$) when the standard enthalpy of combustion of naphthalene is -5153kJ and the standard enthalpies of formation of CO_2 and H_2O are -393.5 and -2.85.8kJ respectively (3 marks)
- c) The enthalpy of solution of anhydrous $CuSO_4$ and hydrated $CuSO_4 \cdot 5H_2O$ are -15.89 and 2.80kcal respectively. using an energy cycle diagram, calculate the enthalpy of hydration of $CuSO_4$ to $CuSO_4 \cdot 5H_2O$ (5 marks)
- d) Explain five characteristics of chemical equilibrium (5 marks)
- e) What is meant by the term 'common ion effect'? (2 marks)

QUESTION FOUR (20 MARKS)

- a) Explain four factors that mainly affects solubility (8 marks)
- b) Calculate the K_{sp} value for bismuth Sulfide (Bi_2S_3) which has a solubility of $1.0 \times 10^{-15} \text{ mol/l at } 25^\circ C$ (4 marks)
- c) A solution contains 1.0 M HCN ($K_a = 6.2 \times 10^{-10}$) and 5.0 M HNO_2 ($K_a = 4 \times 10^{-4}$). Calculate
- The pH of the solution (4 marks)
 - The concentration of cyanide ions (CN) in this solution at equilibrium (4 marks)